Built to Last: The Army's Failed Quest to Replace the Bradley Fighting Vehicle

A Monograph

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On 25 January 2014, the Army Chief of Staff announced the cancelation of the Ground Combat Vehicle (GCV). The GCV's cancelation marked the US Army's most recent failure to design and field a new ground combat vehicle since fielding the Big Five weapon systems in the early 1980's. Today, the Army believes that the BFV does not have the space, weight, or power needed on the modern battlefield. The persistent need for a replacement vehicle and the consistent record of failure to design a replacement strongly suggests there is a serious problem in the Army ground combat system development process. Since the Big Five systems will not last forever, it is important to identify why Army efforts to modernize have failed. By comparing the development dimensions of the FCS and GCV to the standard created by the Bradley, clear differences emerged. Ultimately, the evidence suggests that if the Army intends to replace the Bradley with a new infantry-fighting vehicle, then it must develop more modest program goals at the start of system design and limit the list of new technologies to avoid criticisms of either design or cost.

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Abstract

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On 25 January 2014, the Army Chief of Staff announced the cancelation of the Ground Combat Vehicle (GCV). The GCV's cancelation marked the US Army's most recent failure to design and field a new ground combat vehicle since fielding the Big Five weapon systems in the early 1980's. The Army has long expressed the need to replace the Bradley Fighting Vehicle (BFV) with a new ground combat vehicle. The Bradley, one of the original Big Five, was designed to fight a Cold War threat. Requirements have changed since then but the Army continues to use the BFV as its primary infantry-fighting vehicle.

Today, the Army believes that the BFV does not have the space, weight, or power needed on the modern battlefield. The persistent need for a replacement vehicle and the consistent record of failure to design a replacement strongly suggests there is a serious problem in the Army ground combat system development process. Since the Big Five systems will not last forever, it is important to identify why Army efforts to modernize have failed. However, given the variety of systems and related acquisition and development processes, it is not possible to provide a general explanation. Instead, the research focused on development of the Bradley Fighting Vehicle and its proposed successors, the Future Combat Systems and the Ground Combat Vehicle. These three weapon programs comprise the Army's concentrated efforts to create a new infantry-fighting vehicle and because of this, these three weapons programs provide the most relevant examples of Army ground modernization efforts

By comparing the development dimensions of the FCS and GCV to the standard created by the Bradley, clear differences emerged. First, the strategic context of the FCS and GCV never reached a level of stability that supported the BFV. Second, the manner in which specifications changed for each weapon system led to the conclusion that the BFV, FCS, and GCV experienced requirement creep. Deeper analysis proved this notion wrong. The Bradley was unique since it based its requirements on lofty, yet tangible goals. In contrast, the FCS and GCV created specifications depending on immature and future technology that did not exist at the time of conception and were not achieved during development. Ultimately, the evidence suggests that if the Army intends to replace the Bradley with a new infantry-fighting vehicle, then it must develop more modest program goals at the start of system design and limit the list of new technologies to avoid criticisms of either design or cost.

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Acronyms

AAN	Army After Next
ADP	Army Doctrinal Publication
AMC	Army Materiel Command
ARCIC	Army's Capabilities Integration Center
ARSV	Armored Reconnaissance Scout Vehicle
ARTEP	Army Training and Evaluation Program
ASR	Acquisition Strategy Report
BCT	Brigade Combat Team
BFV	Bradley Fighting Vehicle
CAIG	Cost Analysis Improvement Group
CBO	Congressional Budget Office
CJCS	Chairman of the Joint Chiefs of Staff
CSA	Chief of Staff of the Army
DOD	Department of Defense
FCS	Future Combat Systems
FCV	Future Combat Vehicle
GCV	Ground Combat Vehicle
MICV	Mechanized Infantry Combat Vehicle
MGV	Manned Ground Vehicle
NBC	Nuclear, Biological, Chemical
SAR	Selected Acquisition Report
TACOM	Tank-Automotive Command
TRADOC	Training and Doctrine Command

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Introduction

> "As you know, better than I do, the Army has always had a difficult time explaining just why it needs a particular weapon system and even more difficulty in explaining how that particular weapon system fits in with all of the other Army systems and organizations and finally difficulty in answering the inevitable question as to whether some other combination or alternatives might not be better or more effective."
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> —*TRADOC Commander General William DePuy, January 1975*

On 25 January 2014, the Chief of Staff of the Army announced the cancelation of the Ground Combat Vehicle (GCV).[1] The GCV's cancelation marked the US Army's most recent failure to design and field a new ground combat vehicle since fielding the Big Five weapon systems in the early 1980's. The Army has long expressed the need to replace the Bradley Fighting Vehicle (BFV) with a new ground combat vehicle. The Bradley was one of the original Big Five and originally designed to fight a Cold War threat. Requirements have changed since then but the Army continues to use the BFV as its primary infantry-fighting vehicle.

In the 1980's the US Army fielded five new weapon systems that have shaped how the Army fights since. The 1980's Big Five were the Abrams main battle tank, the BFV, the Apache attack helicopter, the Black Hawk utility helicopter, and the Patriot air defense missile system.[2] The Big Five increased the survivability and lethality of conventional Army forces postured against the Soviet era threat. Since the creation of the Big Five, all attempts to modernize the Army's ground combat fleet have failed. Among the list of failed projects are the Sergeant York anti-aircraft gun, the Crusader artillery canon, the Armored Reconnaissance Scout Vehicle

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[1] Daniel Wasserbly, "Pentagon Budget 2015: Dooms GCV," *HIS Jane's 360*, March 4, 2014, accessed October 14, 2014, http://www.janes.com/article/34841/pentagon-budget-2015-army-s-usd120-5-billion-proposal-drops-end-strength-dooms-gcv.

[2] David C. Trybula, *Big Five Lessons for Today and Tomorrow* (Carlisle Barracks, PA: United States War College, 2012), 3, accessed October 21, 2014, http://www.benning.army.mil/Library/content/NS%20P-4889.pdf.

(ARSV), the Future Combat Systems (FCS), and most recently the Ground Combat Vehicle.[3] The persistent need for a replacement vehicle and the consistent record of failure to design a replacement strongly suggests there is a serious problem in the Army ground combat system development process. Since the Big Five systems will not last forever, it is important to identify why Army efforts to modernize have failed. However, given the variety of systems and related acquisition and development processes, it is not possible to provide a general explanation. Instead, the research focused on development of the BFV and its proposed successors, the FCS and the GCV. These three weapon programs comprise the Army's concentrated efforts to create a new infantry-fighting vehicle and because of this, these three weapons programs provide the most relevant examples of Army ground modernization efforts.[4]

To explain the Army's failure to modernize its ground combat vehicle, it was necessary to examine first, the history of Army modernization beginning with the development of the BFV and then investigate its ill-fated successors: FCS, and the most recent Army modernization attempt, the GCV.[5] Comparing the development histories of these systems reveals both similarities in the development process as well as differences in factors affecting development decisions. The research showed that among the three major weapon systems there were three common dimensions in the development process: strategic context surrounding the development process, system requirements, and cost. However, certain elements within the three dimensions led to decidedly different outcomes. By analyzing the strategic context, requirements, and cost during Bradley development, it was possible to determine an initial set of factors needed for

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[3] US Congress, *Technical Challenges of the U.S. Army's Ground Combat Vehicle Program*, (Washington, DC: Congressional Budget Office, 2012), 5.

[4] Note: Research only included weapon systems relevant to US Army Infantry Fighting Vehicle modernization.

[5] Andrew Feickert, *The Army's Ground Combat Vehicle Program: Background and Issues for Congress* (Washington, DC: Congressional Research Service, 2014), accessed October 14, 2014, http://www.fas.org/sgp/crs/weapons/R41597.pdf.

success. After analyzing the Bradley development history, then it was possible to compare the development process for both FCS and GCV. The comparison illuminates differences in each process that led to their cancelation.

The comparison between the development processes for the BFV, FCS, and GCV revealed that during the Bradley's development, designers and policy makers allowed significant adjustments in the vehicle requirements and rising cost was not a decisive consideration. This was true because the need for the vehicle was widely recognized and the strategic context was stable.[6] The BFV's strategic context was a stable Cold War environment that led to a general agreement on the requirement for a new combat vehicle. The lack of an appropriate alternative or preexisting piece of equipment also aided the Bradley. Despite the Bradley's design and production history, developers had a clear vision of a future Soviet adversary.[7] In this sense, the strategic context of the Cold War supported the creation of the BFV and kept requirement creep and cost growth as non-issues.

In contrast to the Bradley, the FCS and GCV developed in a changing strategic context. The initial requirements for each vehicle counted on immature technology that did not exist. When an appropriate amount of new technology became available to move the two weapon systems forward, the strategic context had shifted enough to draw congressional attention to growing costs and extended timelines.[8] With the Bradley in service as the primary infantry-fighting vehicle, that attention led to doubt concerning the relevance of a new multi-billion dollar weapon system that did not provide much more than already available in the Bradley.

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[6] George F. Hofmann and Donn A. Starry, eds., *Camp Colt to Desert Storm: the History of U.S. Armored Forces* (Lexington, KY: The University Press of Kentucky, 1999), 320.

[7] Ibid.

[8] Christopher Pernin, *Lessons from the Army's Future Combat Systems* (Washington, DC: RAND, 2012), 215.

In many ways, the Bradley was birth in ideal conditions and those conditions have not reemerged. The United States has not had a Cold War, or even stable, threat to plan against since the fall of the Soviet Union. A stable strategic context allows for flexibility, as seen in the Bradley, when requirements and cost grow out of the original scope. Additionally, the BFVs continuing successful record makes justifying the need for a new multi-billion dollar weapon system extremely difficult. A lack of strong support from members of the DOD and congressional policy makers contributes to revisions, increased costs, and formal reviews that question the necessity to replace the BFV. In the end, those factors doomed the FCS and GCV. Evidence suggests those same factors will continue to plague the development of the next infantry-fighting vehicle as well.

The Bradley Fighting Vehicle

The infantry-fighting vehicle that is in use today in the US Army is the product of multiple failed programs over the course of 25 years.[9] Over the course of the Bradley's development, several unique dimensions separated its experience from that of its ill-fated successors. During that time, several strategic events affected its development. The closing years of the Vietnam War and use of armored vehicles by potential adversaries during the 1973 Yom Kippur War were major strategic events that ultimately shaped the creation of the BFV. Analysis of the development process that led to the fielding of the BFV reveals the manifold factors that influenced the course of the development. It also shows the specific, unique factors in each of the three development dimensions that led to success. The Bradley was the last major ground combat

[9] George F. Hofmann and Donn A. Starry, eds., *Camp Colt to Desert Storm: the History of U.S. Armored Forces*, 403.

vehicle modernization effort to succeed.[10] Every attempt to replace the Bradley has failed. Therefore, analysis of the BFV's development considering the three design dimensions: strategic context, requirements, and cost, provides a base with which to compare the FCS and GCV development. Although the production of the BFV and its relationship to the Big Five is widely considered the gold standard of Army acquisition programs, the record shows that the process was far from perfect.[11]

Strategic Context

The Bradley Fighting Vehicle development began in the 1950's with specification of an initial concept. In 1958, the US Army Infantry School recommended development of an armored vehicle, capable of carrying an infantry squad with enough protection and firepower to maneuver with tanks. The "Infantry Fighting Vehicle" (IFV) was the original name of the armored vehicle.[12] The IFV intended to revolutionize the way infantry soldiers fought on the battlefield. Before the creation of the IFV, the M113 was the primary armored vehicle used to move infantry soldiers. The M113 was lightly armored and armed with a .50 caliber machine gun.[13] The M113's original design sought to provide modest protection from artillery and small arms fire. The M113 was not a fighting vehicle and was little more than a battle taxi. However, the M113 was not suited for maneuver in close proximity with the heavily armed and well-protected tank. Thus, the proposed IFV was not replacing an existing capability. It represented a new tactical concept that

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[10] W. Blair Haworth, *The Bradley and How It Got That Way: Technology, Institutions, and the Problem of Mechanized Infantry in the United States Army* (Contributions in Military Studies) (Connecticut: Greenwood Press, 1999), 89.

[11] Ibid.

[12] Haworth, *The Bradley and How It Got That Way*, 42.

[13] US Congress, *A CBO Study: The Army's Future Combat Systems Program and Alternatives* (Washington, DC: Congressional Budget Office, 2006), 64.

was to be a unique capability, not shared with any of its predecessors. The end of the Vietnam War and start of the Cold War would shape the ultimate outcome of this unique capability.

The height of the Vietnam War presented for the Army both risk and the opportunity to field of a new ground combat vehicle. The period between 1960 and 1970 was a volatile time in which to renew interest in a new weapon system. There were leaders who used their experience in Vietnam to ensure future formations were equipped with the best available technology. Brigadier General George W. Casey was one of those leaders.[14] Based on his experience as a brigade commander in Vietnam, Casey argued in 1968 that a mechanized infantry vehicle to accompany tanks in a combined arms relationship was a necessity. He also recommended producing two different fighting vehicle variants to support the infantry and the cavalry.[15] Despite the best efforts from Casey and other supporters, the development of the IFV continued to lag and faced cancelation. Fortunately, the IFVs future relied less on internal Army assessments and more on the strategic impact of a new Soviet infantry-fighting vehicle, the *Boyevaya Mashina Pekhoty* (BMP).[16]

Strategically, the introduction of the BMP had a positive impact on the IFVs development because the Army focused doctrine development and reorganization on the emerging Soviet tactical threats.[17] When post-Vietnam funding cuts threatened to terminate the infantry fighting vehicle program, the BMP confirmed the need for a new fighting vehicle.[18] During the 1973, Yom Kippur War the BMP was a key weapon system.[19] The Yom Kippur War and the combat

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[14] Hofmann and Starry, *Camp Colt to Desert Storm*, 405.

[15] Ibid., 406.

[16] Hofmann and Starry, *Camp Colt to Desert Storm*, 407.

[17] Ibid.

[18] Ibid.

[19] Ibid.

use of the BMP played a critical role in the successful development of the BFV. The Soviet BMP gave the IFV developers a near peer competitor that reinvigorated the program holistically. The BMP transported infantry personnel in an armored vehicle. It was fast, well-armed and provided protection against a hostile NBC environment.[20] Extensive studies of the BMP identified these capabilities as a new set of requirements for the IFV. Developers again demanded enhanced capabilities without sacrificing design parameters. This increased cost to a point that buying foreign equipment or simply upgrading the M113 became options. However, despite setbacks and design variations, the Cold War strategic context ensured development of a new infantry-fighting vehicle.[21]

Cold War strategic concerns put a premium on a heavy armored force capable of defeating a Soviet threat. However, the US Infantry School was not the only population interested in a new vehicle. While the infantry community continued to push forward with the IFV, the armor community had plans to create an armored vehicle suited for reconnaissance. Shortly after the Yom Kippur War, the Army submitted requests for proposals for the XM800 Armored Reconnaissance Scout Vehicle (ARSV).[22] The reconnaissance platform was a separate program with specifications that differed from the IFV. The turret of the ARSV was to accommodate two people to enhance observation. Despite the differences in the two vehicles, the ARSV followed the same design path as the IFV. Designers demanded greater capability while maintaining maneuverability at lower costs. Curiously, this problem only slowed the IFV production while proving catastrophic for the ARSV. In 1975, the ARSV program ended and became part of the IFV program of record.[23] This added complexity to an already complex problem. Now a new set

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[20] Haworth, *The Bradley and How It Got That Way*, 48.

[21] Ibid., 67.

[22] Ibid., 69.

[23] Ibid., 75.

of specifications to meet the needs of both the infantry and armor branches was required. In 1975, the idea of producing an armored infantry-fighting vehicle that could operate alongside tanks against the Soviets looked like an unrealistic goal. The Army required a new organization in order to manage the infantry-fighting vehicle development. A new Army institution and its first commander, General William DePuy stepped in and provided support for the IFV.

In 1973, the US Army established the Training and Doctrine Command (TRADOC) and DePuy was its first commander.[24] DePuy understood the IFV's combat development and created the Army Training and Evaluation Program (ARTEP) to match material development with equipment requirements.[25] However, ARTEP was only half of solution to the IFV's problems. DePuy determined that without a strong tactical doctrine for the employment of the BFV, the program would fail. In 1976, DePuy published a new addition of FM 100-5 that addressed that problem. Drawing heavily on the lessons learned from Yom Kippur War, DePuy's "Active Defense" doctrine finally highlighted the use of the IFV as a key requirement in confronting the Warsaw Pact.[26] A formalized doctrinal need gave a major push for the IFV's continued development. However, a 1977 General Accounting Office (GAO) report questioned whether the IFV was the right vehicle to meet the doctrinal requirement and properly address the Cold War strategic context[27]

Drawing observations from the 1976 FM-100, *Operations*, the GAO report presented findings to Congress on the IFV from its internal review.[28] The report acknowledged that the

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[24] Hofmann and Starry, *Camp Colt to Desert Storm*, 408.

[25] Ibid., 409.

[26] Major Paul H. Herbert, *Deciding What Has to Be Done: General William E. Depuy and the 1976 Edition of Fm 100-5, Operations* (Leavenworth, KS: Combat Studies Institute, 1988), 79.

[27] General Accounting Office, *The Army's Proposed Close Combat Vehicle Team* (Washington, DC: GAO, 1977), 12.

[28] Haworth, *The Bradley and How It Got That Way*, 85.

Yom Kippur War highlighted the utility of a combined arms force on the battlefield. However, the report criticized the current IFV design and questioned how it would fight alongside the heavily armored tank. The report concluded that the largest problem with the IFV design was the fact that while doctrine existed for M60/M113 tactics, a doctrine that covered tank/IFV tactics did not exist. The report claimed the Army was following a poor modernization model by designing equipment before it knew how to employ it. The GAO report recommended that the Army stop production and complete its written plan first.[29] Based upon the GAOs recommendation, the Office of Management and Budget (OMB) deleted funding for the IFV from the 1979 Presidential budget request, essentially terminating the program.[30] Fortunately, the IFV still had supporters committed to seeing the project through to production. Support from DePuy, General Donn A. Starry, and two separate congressional task forces were required to keep the IFV program alive. Through their combined efforts, they were able to convince Congress that designs for an infantry and cavalry model of the IFV were necessary and appropriate. Crucial in the argument for the IFV was the recognition that there were no alternative vehicles ready for purchase from an ally.[31] Consequently, the first IFV rolled off the production line on 8 May 1981. On October 1, 1981, the IFV received the name "Bradley Fighting Vehicle" in honor of General Omar N. Bradley who had died six months prior.[32] The strategic context of the Cold War during the development of the IFV had ensured that Congress recognized the need to continue production.

The strategic context during the BFV's twenty-five years of development changed from a focus on military activity in Vietnam, to an Army prepared to fight the Soviets on European plains. As the Cold War strategic context stabilized, so did the process in which the Army

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[29] General Accounting Office, *The Army's Proposed Close Combat Vehicle Team,* 12.

[30] Haworth, *The Bradley and How It Got That Way*, 87.

[31] Ibid., 89.

[32] Hofmann and Starry, *Camp Colt to Desert Storm,* 426.

designed new weapon systems. With a stable strategic setting and focused enemy, it was easier to accept issues with requirements creep and cost. A stable strategic setting was a condition unique to the Bradley's development and a condition not shared by either of its attempted successors. The major events in history discussed in this section are critical factors in determining why the BFV project succeeded while its predecessors have failed. However, context is not the only factor that played a role in the development of the BFV. The system's requirements were also a major point of contention.

System Requirements

The Bradley's tenuous design history has been widely publicized due in part to James Burton's book, *The Pentagon Wars*, and the 1998 motion picture based on the book.[33] The common criticism of the BFV development process includes the changing list of requirements placed on the weapon system and the associated cost of adding capabilities without sacrificing utility. An initial lack of tactical doctrine governing the use of the BFV allowed requirements to expand as mission needs evolved.[34]

The BFV went through several different designs and prototypes before it became the vehicle it is today, as shown in Figure 1. The first Bradley design, then called the mechanized infantry combat vehicle (MICV), was to replace the M113.[35] In 1958, the M113 was the Army's standard battlefield armored transport vehicle and saw combat throughout the Vietnam War. It is important to note that the M113 was not an infantry-fighting vehicle and, therefore, while the BFV design intended to replace the M113, it would offer new capabilities. As stated earlier, Casey and the US Infantry School were early advocates for a replacement to the M113 because

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[33] James G. Burton, *The Pentagon Wars: Reformers Challenge the Old Guard* (Annapolis, MD: Naval Institute Press, 2014), 132.

[34] Haworth, *The Bradley and How It Got That Way*, 85.

[35] Burton, *The Pentagon Wars: Reformers Challenge the Old Guard*, 133.

they envisioned a closer tactical role for infantry and the XM-1, the Army's new main battle tank under development. Yet, the M113 had several key features that developers wanted the new MICV to retain. The M113 could carry a full infantry squad, which at the time was 11 soldiers, and moved quickly over rough terrain.

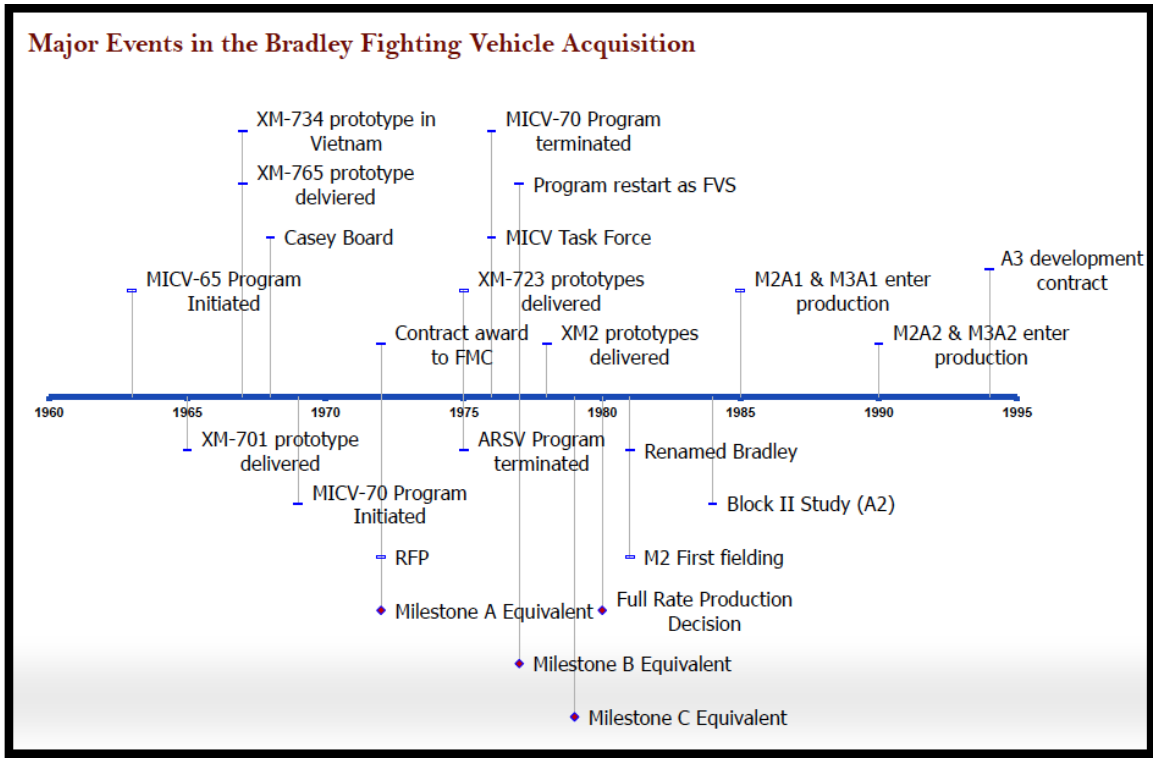

Figure 1. Development History of the Bradley Fighting Vehicle 1960-1996

Source: David C. Trybula, *Big Five Lessons for Today and Tomorrow* (Carlisle Barracks, PA: United States War College, 2012), 26.

It also could ford minor water obstacles when needed and easily transported on a C-141 transport aircraft. These features were all desirable in the new MICV. The initial attempts to produce the MICV, however, failed because developers wanted greater capabilities at lower prices without sacrificing any design features.[36]

[36] Haworth, *The Bradley and How It Got That Way*, 44.

The first MICV test bed was the XM701, created by the Pacific Car and Foundry in the late 1950's.[37] The XM701 resembled a M113, but looked more like a M110 self-propelled howitzer because it used that chassis and power train.[38] The XM701 could carry 12 personnel and was armed with a 20mm cannon and 7.62 machine gun. The XM701 was also amphibious and had an overpressure feature to protect the interior from a nuclear, biological, or chemical threat. As a prototype, the XM701 met the basic M113 replacement requirements. However, the XM701 weighed 28,000 pounds more than the M113, which greatly reduced the vehicle's strategic mobility. The XM701s weight alone made it unlikely move forward in the development process.[39]

In August 1976, the entire MICV program made a major course correction that led directly to the weapon system known today as the BFV. The arrival of the Soviet BMP and its use in combat during the 1973 Yom Kippur War led Army leaders and policy makers to question whether the MICV could meet future requirements.[40] To address these questions, the Congress formed the MICV Task Force to conduct an independent study of the MICV program. System requirements changed because of the task force's findings. Led by Brigadier General Richard Larkin, Assistant Commander of the 4th Infantry Division, the task force made three recommendations.[41] First, the infantry-fighting vehicle needed to carry a nine-man squad and utilize a two-man turret. Second, the vehicle required at least 14mm of armor, maintain the ability to swim, and have a 25mm cannon with tube-launched, optically tracked, wireless-guided (TOW)

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[37] Christopher F. Foss, ed., *Jane's Armour and Artillery 2011-2012*, 32 ed. (New York: Janes Information Group, 2011), 443.

[38] Haworth, *The Bradley and How It Got That Way*, 43.

[39] Ibid., 44.

[40] Foss, *Jane's Armour and Artillery 2011-2012*, 442.

[41] Hofmann and Starry, *Camp Colt to Desert Storm*, 419.

missile launching capability. Third, a single vehicle design could satisfy requirements for use as both an infantry vehicle and a cavalry vehicle. Larkin's recommendations were accepted by Congress in October 1976 and the program was officially designated the Fighting Vehicle System (FVS) that consisted of the XM2 Infantry Fighting Vehicle (IFV), and the XM3 Cavalry Fighting Vehicle (CFV).[42] The BFV's requirements stayed relatively stable during the next five years of development, with only minor design corrections before going into full production in 1981.

This research shows that US Army found it difficult to develop a logical list of requirements for a new weapon system. The conflict between what the Army wanted in the new infantry fighting vehicle and what it could realistically produce plagued production throughout the system's development cycle. Requirements for the BFV changed quickly and often without a formal doctrine to guide system requirements for most of the BFVs development history. There was harmony in the design process only when doctrine matched the need for the weapon system. Nevertheless, the evolutionary character of the BFV did not occur in a vacuum. As the desire for the BFV to do more with less went up, so did the price of development.[43]

Budgetary Requirements

The BFV program succeeded despite the fact that program costs grew 900 percent beyond original system cost estimate.[44] Figure 2 depicts program cost growth of the BFV compared to the other Big Five systems. The overall cost to develop the BFV grew as the list of requirements grew. However, the fact that the BFV program survived despite program costs rising from $281 million in 1973, to an astonishing $3.9 billion in 1981 is exceptional. While the

[42] Hofmann and Starry, *Camp Colt to Desert Storm*, 419.

[43] Haworth, *The Bradley and How It Got That Way*, 89.

[44] Trybula, *Big Five Lessons for Today and Tomorrow*, 97.

production cost growth is a negative indicator of program management, it is important to note that during the production timeline of the BFV standardized monetary thresholds to determine spinout programs did not exist.[45] Meaning cost growth in the Bradley would not trigger a congressional review. In 1982, the Nunn-McCurdy Act incorporated standardized thresholds in the acquisitions process. The standardize thresholds link the Bradley's budgetary concerns to the two other

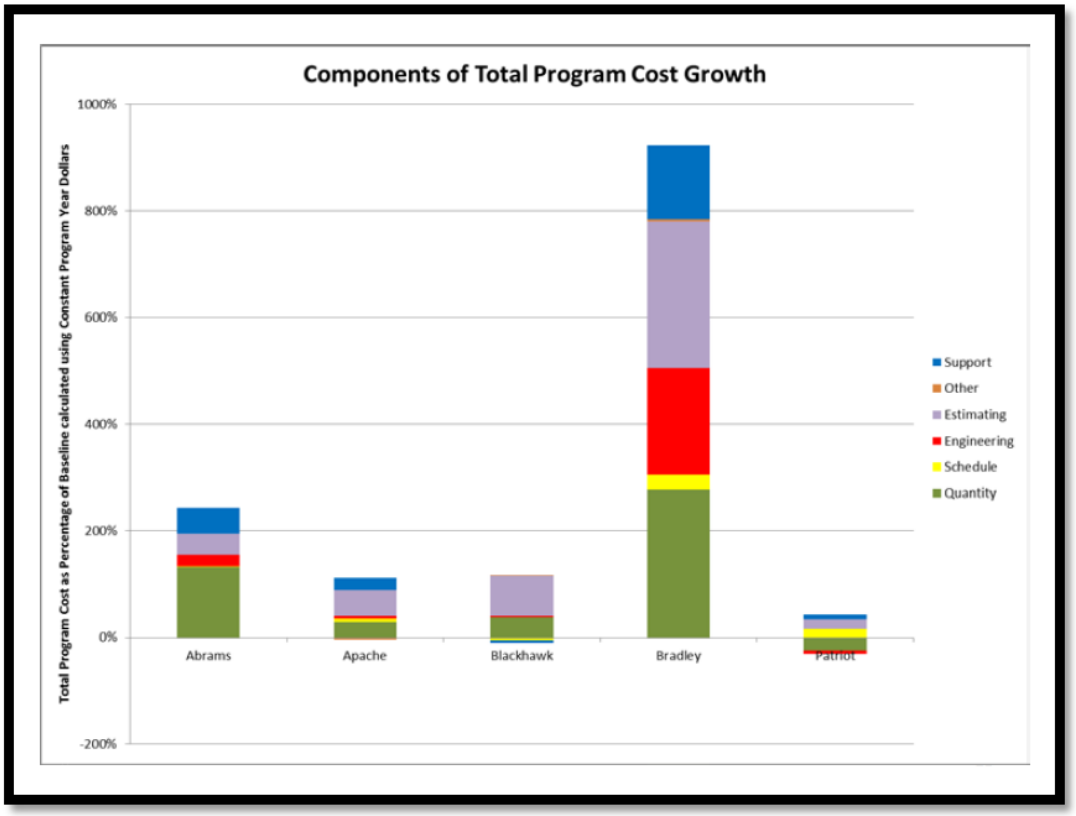

Figure 2. Cost Growth of Big Five Weapon Systems

Source: David C. Trybula, *Big Five Lessons for Today and Tomorrow* (Carlisle Barracks, PA: United States War College, 2012), 31

weapon systems discussed in this monograph.

[45] Trybula, *Big Five Lessons for Today and Tomorrow*, 31.

President Reagan signed the Nunn-McCurdy Act. This act requires the Department of Defense (DOD) to report to Congress whenever a program experiences a fifteen percent growth in program acquisition unit cost (PAUC).[46] This act explains why the BFV program was successful in spite of ballooning product costs, while the FCS and GCV were not. Had the Nunn-McCurdy provisions been in effect during the BFV's development, a review would have occurred in 1978.[47] Since the act did not exist at that time, there was no requirement to submit a report and no subsequent review. Some of the provisions in the Nunn-McCurdy Act have also changed since inception in 1982. In 2009 under the Weapon Systems Acquisition Reform Act, further constraints to the Nunn-McCurdy Act stated any weapon system that experienced a breach of established thresholds was subject to termination until the Secretary of Defense has conducted a thorough review.[48] The added scrutiny had dire implications for the FCS program. However, the Bradley was late in the development stage when the Reagan signed the act into law. It, therefore, had no impact on the BFV. Figure 3 depicts when the Nunn-McCurdy Act threshold would have triggered a major review.[49]

Figure 3 graphically depicts BFV production cost growth from 1973 through 1991. The data for this figure came from the Select Acquisition Reports (SARs). SARs are congressional reviews of major weapon systems conducted by the Department of Defense.[50] The blue bars depict production costs and the number directly above the blue bar is the planned procurement

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[46] Moshe Schwartz, "The Nunn-McCurdy Act: Background, Analysis, and Issues," *Congressional Research Service*, accessed October 27, 2014, http://fpc.state.gov/documents/organization/145135.pdf.

[47] Trybula, *Big Five Lessons for Today and Tomorrow*, 31.

[48] Ibid.

[49] Trybula, *Big Five Lessons for Today and Tomorrow*, 33.

[50] Ibid., 30.

quantity for that given year. The red line represents the program acquisition unit cost (PAUC) which is simply the program cost divided by the quantity requested.[51] As seen in Figure 3, the PAUC rose steadily through 1976. After the MICV Task Force changed requirements for the BFV, the price skyrocketed to its peak of $3.9 million in 1981. Two phenomena explain this activity. One, the price creep relates directly to minor design adjustments and prototype development through 1976. The MICV Task Force called for major requirement changes in 1976 and as the BFV moved closer to its programmed production point, significant overhaul of supporting BFV systems were required to make the vehicle usable in combat.[52]

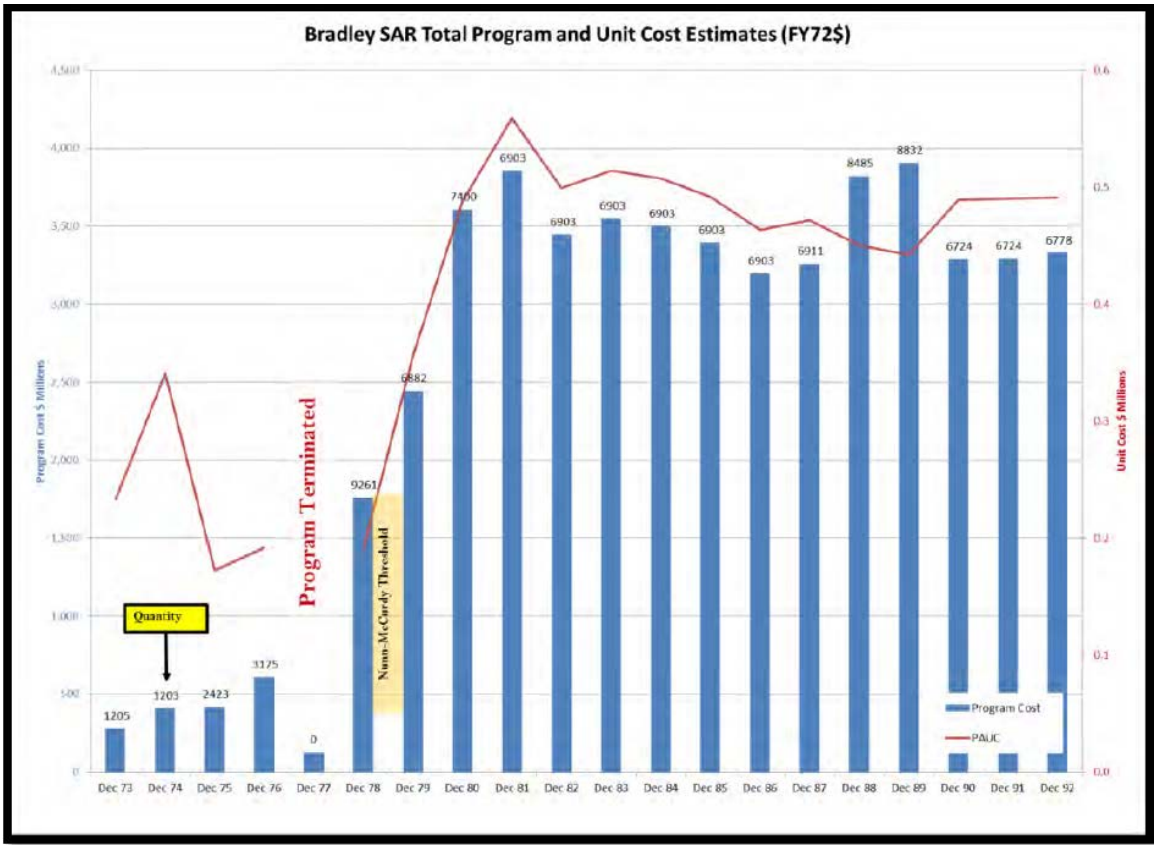

Figure 3. Bradley Selected Acquisition Report Total Program and Unit Cost Estimates

Source: David C. Trybula, *Big Five Lessons for Today and Tomorrow* (Carlisle Barracks, PA: United States War College, 2012), 31.

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[51] Trybula, *Big Five Lessons for Today and Tomorrow*, 31.

[52] See figure 3.

The evidence shows the development process of the BFV looks more like a calamity than the gold standard of weapon system acquisition. A number of issues plagued the development process. Over the course of twenty-five years, the requirements changed drastically between the IFV start as in 1960 to the production version of the Bradley in 1981. System requirements changed often to address desires for the BFV to accomplish a wide range of military activities. As requirements grew, so did the cost. As shown in Figure 3, if the BFV was subject to today's acquisition policies, undoubtedly development issues would have expanded with each additional report and investigation. Yet in the end, the strategic context from 1960 through 1983 gave the BFV the lifeline it needed to make it through development to production.

The production history of the BFV provides basis for comparison between it and its two failed successors by highlighting what made the BFV unique. Three main factors explain why the Bradley weathered the development storm of radical requirement and design changes, extreme cost growth, and questionable tactical doctrine. First, the Cold War strategic context gave designers a goal to achieve. Second, congressional regulatory acts were not in place to add additional scrutiny to the development of the Bradley. Third, the Bradley was filling a well-defined void in the Army's ground combat vehicle inventory. These three points make the BFV unique. Comparison of FCS and GCV development reveals the extent to which those programs diverged from the path that made the Bradley successful.

Comparison of Strategic Context

To determine where and to what extent the FCS and GCV diverged from what made the BFV successful, it is necessary to compare each weapon system by the three design dimensions. The evidence suggests that neither the FCS nor the GCV benefited from a stable strategic context like the context that supported development of the BFV. The following section compares the effect that strategic context had on the FCS and GCV weapon systems. In contrast to the BFV, the strategic context did not favor the FCS and GCV and contributed to failure of both programs.

The FCS program came to being in 1999 and met termination in 2009.[53] At the time of conception, the FSC program was the largest acquisition program ever attempted by the US Army. As shown in Figure 4, the FCS was to have been a system of systems. All systems would be interconnected and capable of transforming the heavy Cold War brigade into a lighter, more agile fighting formation.[54] Initially, the strategic impact of the Cold War's end and a new focus on rapidly deployable forces supported the creation of a new infantry-fighting vehicle that was lighter and more agile than the existing BFV. However, in the decade that spanned 1999 to 2009, the strategic context changed the tactical needs considerably. Unlike the BFV's stable Cold War strategic context, the FCS's strategic context was not stable, and the conditions that originally supported the program shifted significantly, undermined the vehicles rational, and led to cancelation.

Figure 4. The FCS Program

Source: Christopher Pernin, *Lessons from the Army's Future Combat Systems* (Washington, DC: RAND, 2012), 2.

[53] Pernin, *Lessons from the Army's Future Combat Systems*, 27.

[54] Ibid., 1.

In the early 1990's the Cold War ended, and with it the threat from the Soviet Union. Thus, the utility of the force designed to fight the Soviets came into question. Without a clear enemy threat, the Army modernization efforts lacked strategic direction. However, in 1991 Operations Desert Storm gave Army leaders an indication of what the future conflicts might look like. The initial deployment to Operation Desert Shield highlighted the fact that the Army required a significant amount of time to build up combat power before ground operations could commence.[55] Later operations in Somalia, Bosnia, and Kosovo reinforced the observation that the Army could not rapidly deploy its current heavy formations.[56] During this same period, Army and Joint doctrine also changed to support lighter and more agile forces. Three documents in particular supported the development of the FCS program: Joint Vision 2010, Army Vision 2010 and the 1994 TRADOC PAM 525-5.[57] In these forecast documents, a more agile and flexible land force was to be the result of improvements in information technology and weapons precision. These documents laid the foundation for the Army's Force XXI transformation. Force XXI was to be the answer and provide the more agile land force outlined in Joint Vision 2010. With the foundation set, the Army required a spokesperson and a vehicle to drive change within the organization. The Chief of Staff of the Army, General Eric Shinseki, became the spokesperson and the FCS was the vehicle.[58]

In 1999, at the annual Association of the United States Army (AUSA) convention, Shinseki delivered a speech that was pivotal in the creation of the FCS program. In that speech, he called upon the experience of the Army during the past decade and vowed to transform the

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[55] Pernin, *Lessons from the Army's Future Combat Systems,* 6.

[56] Robert Bradford, *What Happened to the FCS? An Organizational Change Case Study,* Strategy Research Project (Carlisle Barracks, PA: United States Army War College. 2011), 2.

[57] Pernin, *Lessons from the Army's Future Combat Systems,* 6.

[58] Ibid., 8.

Army into a "strategically responsive force that is dominant across the full spectrum of operations."[59] Additionally, he established deployment goals for the rapid deployment of a brigade sized force. Training and Doctrine Command took the general priorities laid out by Shinseki and translated them into the initial requirements for the FCS program.[60] At first, the strategic context for the FCS looked promising. There were leaders in place to promote the FCS program and there were doctrinal publications to underpin requirements. However, unlike the relatively constant nature of the Cold War during the BFV program, the strategic context of the FCS program would change on September 11, 2001.

After the attack on September 11, the strategic focus shifted from addressing an unknown future enemy to addressing a known threat in the present. During Operations Enduring Freedom and Iraqi Freedom, the FCS program continued but under drastically different circumstances. Since the FCS program relied on leap-ahead technologies and future development, there was no possible way to speed up delivery of such systems for use in Iraq or Afghanistan. Furthermore, the lessons learned coming out of OIF and OEF did not support the design of the manned ground vehicle (MGV) portion of the FCS program.[61] This problem was elevated in importance by increasing scrutiny from the GAO and CBO who were concerned with the growing program cost estimates. In light of these facts, on April 6, 2009, then Secretary of Defense Robert Gates recommended cancelation of the MGV portion of the FCS, and with it, the Army's initiative to replace the BFV. Gates concluded that the weapon systems under the FCS program did not

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[59] Rowan Scarborough, "Army Chief of Staff Vows Total Force Restructuring; Envisions Swifter, Less Costly Deployments," *The Washington Times,* October 13, 1999, p. A1.

[60] Ibid.

[61] Helen Lardner, *The Army's Quest for a New Ground Combat Vehicle,* Strategy Research Project (Carlisle Barracks, PA: United States Army War College. 2010), 1.

accurately reflect the needs of soldiers in a counterinsurgency and close quarters fight.[62] In the case of the FCS program, the strategic context shifted from conditions advantageous to new development and production to conditions that put the basic requirements of the program at odds with current realities. In this sense, the strategic context of the FCS program has more in common with the strategic context of the Army's most recent failed attempt to modernize the BFV, the GCV program.

One year after Gates recommended termination of the FCS program, the Army issued a request for proposal (RFP) for the Ground Combat Vehicle.[63] In the case of the GCV, the strategic context had not changed from the context that supported the cancelation of the FCS program. However, the strategic context that was common with both programs influenced the design and structure of what would the Army's second attempt to replace the BFV. In contrast to the FCS program that found itself unsuited for fighting a counterinsurgency, the initial GCV design incorporated the lessons learned from Iraq and Afghanistan with a desire to remain relevant across all functions of the Army. However, similar to the FCS program, the strategic context in 2010 changed.

In 2010, the strategic context included two realities. One, the United States was still engaged in a counterinsurgency fight in both Iraq and Afghanistan. Second, the Army was convinced it needed a replacement to the BFV to address adversaries in the future. That nexus brought about the request of proposal document for the GCV. Unfortunately, a combination of critical strategic events shifted the Army's view of the future enough to question the validity of building an infantry-fighting vehicle designed for a counterinsurgency. First, the United States

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[62] Robert M. Gates,", "The National Defense Strategy, Striking the Right Balance," *Joint Force Quarterly*, Issue 52, 1st Quarter, 2009.

[63] Andrew Feickert, *The Army's Ground Combat Vehicle (GCV): Background and Issues for Congress* (Washington, DC: Congressional Research Service, 2005). 6.

had decided to end its combat mission in Iraq and in 2012, announced that there was a new Asia-Pacific focus for the Department of Defense.[64] Additionally, domestic politics affected the strategic context in the form of sweeping Defense budget sequestration that cut most funding for the GCV. All of this concluded on February 24, 2014 when Secretary of Defense Charles T. Hagel announced that the termination of the GCV program in the Department of Defense's FY2015 budget. Hagel's speech marked the end of the GCV program and the Army's second failed attempt in five years to replace the Bradley series infantry-fighting vehicle.[65]

When all three infantry fighting vehicle programs are considered, a key difference emerges between the success of the BFV and its two failed successors. The strategic context that dominated the creation of the Bradley fighting vehicle shifted slightly, but remained relatively constant during the Cold War. During this period, the Army was creating an armored infantry-fighting vehicle to support tanks against a known Soviet threat. A key distinction here is the Bradley was going to provide a capability that did not already exist. Furthermore, the creation of new Army institutions, like TRADOC, further supported development of new weapon systems and subsequent doctrinal integration. These elements stand in contrast to the strategic context that dominated the design of both the FCS program and the GCV. During the lifetime of both of these systems, the strategic context changed leaving policy makers and bill payers to question the utility of a system that existed to meet different strategic requirements. Additionally, the FCS program and GCV were not filling a void in Army capability; they were replacing an already functioning system that had been battle proven in the sands of both Iraq and Afghanistan. The comparison of the Bradley's strategic context to that of the FCS and GCV highlights a difference that had an effect on the systems ultimate demise. However, the evidence does not support the

[64] Feickert, *The Army's Ground Combat Vehicle (GCV),* 8.

[65] Ibid., 10.

conclusion that strategic context alone doomed the FCS and GCV. To determine the full pattern of failure, examination of the two development dimensions of requirements and cost is essential.

Comparison of System Requirements

The impact of strategic context on modernization showed that changes in the strategic context during the lifetime of a development project could greatly affect the outcome of that weapon system. The evidence suggests that the Army has a history of changing initial requirements to meet changing contexts. Shifts in system requirements can cause serious turbulence in weapon system development and undermine modernization efforts.[66] This condition, commonly referred to as requirements creep, occur when system requirements begin to drift away from the initial set of requirements. The evidence indicates that although the FCS and GCV experienced requirements creep similar to the BFV over the course of their development, policy makers and the Congress were willing to accept changes to the Bradley but hostile to changes for the FCS and GCV.

By comparison, the FCS program had a history of requirements creep and its own major program shifts, but on a much larger scale. The MGV component of the FCS program was originally just one of 18 systems that would ultimately make up the FCS systems. Each of the individual systems would rely on each other, making the acquisition process extremely complex. As requirements and future technology developed and changed, so did each associated system.[67] These layers of complexity created conflicts between FCS program requirements. First, the FSC program's initial requirements were constrained by the perceived need to transport the MGV portion of the FCS on a C-130. Second, the entire program received optimization for conventional

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[66] Pernin, *Lessons from the Army's Future Combat Systems,* 50.

[67] Ibid., 52.

battle on open terrain. As conflicts in Afghanistan and Iraq continued, these design requirements became less important. Finally, due to the leap-ahead technology needed to achieve the basic system, the FCS program was never truly feasible from the beginning.[68] The combination of these three points ensured the FCS program would not live to replace the BFV.

The initial requirements for the FCS program were born from war-game cycles conducted as part of the Army After Next (AAN).[69] The goal for the AAN war-games was to anticipate Army requirements and capabilities out to the year 2025. The AAN war-games informed, then Chief of Staff of the Army, Shinseki's vision of a force capable of deploying anywhere in the world in 96 hours.[70] However, to meet that requirement the MGV portion of the FCS program needed to be C-17 transportable and possess the ability to fit on a C-130 for intra-theater movement.[71] Shinseki's insistence on C-130 transportability was the main factor restricting the design of the Bradley's replacement.[72] This was a major departure from the development of the

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[68] Pernin, *Lessons from the Army's Future Combat Systems,* 54.

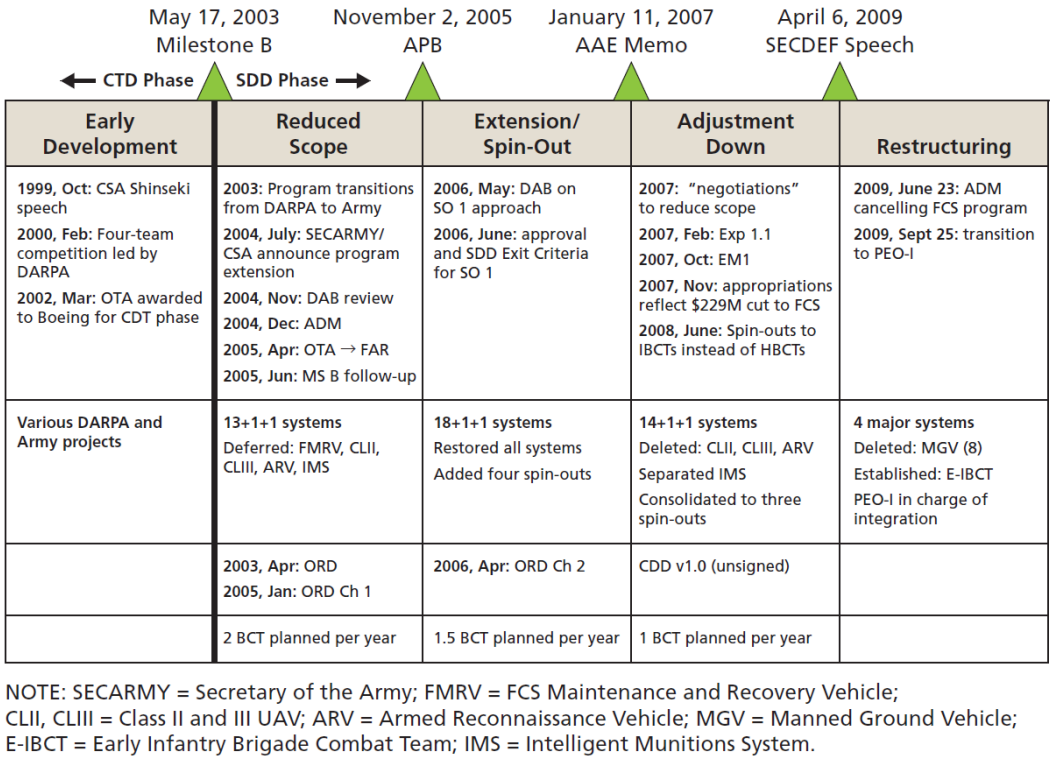
[69] Larry Lynn, *Some Suggestions for the Army After Next* (Leavenworth, KS: Combat Studies Institute, 1996), 4, accessed October 20, 2014, http://usacac.army.mil/cac2/CSI/docs/Gorman/06_Retired/02_Retired_1991_99/17_97_DARPA_ForAAN_1May.pdf.

[70] Pernin, *Lessons from the Army's Future Combat Systems,* 55.

[71] Ibid., 8.

[72] Ibid., 32.

BFV, because the FCS expected to be just as survivable, but weigh significantly less than the Bradley.



Early Development	Reduced Scope	Extension/ Spin-Out	Adjustment Down	Restructuring
1999, Oct: CSA Shinseki speech **2000, Feb:** Four-team competition led by DARPA **2002, Mar:** OTA awarded to Boeing for CDT phase	**2003:** Program transitions from DARPA to Army **2004, July:** SECARMY/ CSA announce program extension **2004, Nov:** DAB review **2004, Dec:** ADM **2005, Apr:** OTA → FAR **2005, Jun:** MS B follow-up	**2006, May:** DAB on SO 1 approach **2006, June:** approval and SDD Exit Criteria for SO 1	**2007:** "negotiations" to reduce scope **2007, Feb:** Exp 1.1 **2007, Oct:** EM1 **2007, Nov:** appropriations reflect $229M cut to FCS **2008, June:** Spin-outs to IBCTs instead of HBCTs	**2009, June 23:** ADM cancelling FCS program **2009, Sept 25:** transition to PEO-I
Various DARPA and Army projects	**13+1+1 systems** Deferred: FMRV, CLII, CLIII, ARV, IMS	**18+1+1 systems** Restored all systems Added four spin-outs	**14+1+1 systems** Deleted: CLII, CLIII, ARV Separated IMS Consolidated to three spin-outs	**4 major systems** Deleted: MGV (8) Established: E-IBCT PEO-I in charge of integration
	2003, Apr: ORD **2005, Jan:** ORD Ch 1	**2006, Apr:** ORD Ch 2	CDD v1.0 (unsigned)	
	2 BCT planned per year	1.5 BCT planned per year	1 BCT planned per year	

NOTE: SECARMY = Secretary of the Army; FMRV = FCS Maintenance and Recovery Vehicle; CLII, CLIII = Class II and III UAV; ARV = Armed Reconnaissance Vehicle; MGV = Manned Ground Vehicle; E-IBCT = Early Infantry Brigade Combat Team; IMS = Intelligent Munitions System.

Figure 5. Timeline for FCS Program

Source: Christopher Pernin, *Lessons from the Army's Future Combat Systems* (Washington, DC: RAND, 2012), 27.

The C-130 transportability requirement was at the heart of the FCS program and became the dominant design feature throughout its development period. FCS developers believed that if an early response force, equipped with FCS technology, could rapidly deploy into a conflict then it could stop the enemy from building combat power. As seen in Figure 6, rapid deployment would reduce the overall enemy force capability. Yet to deploy rapidly, the vehicle must weigh no more than nineteen tons if it is to travel in a C-130. In comparison, the weight of the BFV is thirty-two tons. The implied successor to the BFV would have to weigh thirteen tons less, while remaining just as lethal and durable. In the case of the MGV portion of the FCS, weight had a

direct correlation to survivability. Armor provides protection for ground combat vehicles, and it is logical that adding more armor makes a vehicle heavier. This was the key obstacle for the FCS program.[73] It was an obstacle because this fact put transportability in direct odds with survivability. Obviously, this is not an optimal situation for any acquisition program and one of the main reasons the C-130 transportability requirement was an obstacle to overall system success. The tension between survivability and transportability meant that sacrifices occurred to accommodate one of the two design features. Since C-130 transportability was the priority, risk was assumed in survivability.

The next critical tension in the FCS program was the fact that initial requirements optimized the MGV portion of the program for a conventional, open terrain fight.[74] Variables such as speed and light armor were key features to the MGV. However, the operating environment changed to a counter-insurgency fight, one often littered with Improvised Explosive Devices (IED). The initial vehicle specifications did not address the changing environment or the emerging IED threat.[75] The MGV's original design had a flat, interchangeable hull that sat only 18 inches above the ground. As IED data from both Afghanistan and Iraq became widely available, questions arose about the survivability of the MGV. In 2009, Chief of Staff of the Army, General George W. Casey, testified before the Senate Armed Services Committee (SASC) that the MGV was not suitable in the current operating environment due to its vulnerability to IEDs. He observed that the MGV chassis should have a V-shaped hull to improve survivability against IEDs.[76] Yet at this point in the design process, the MGV had already exceeded weight

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[73] Pernin, *Lessons from the Army's Future Combat Systems,* 58.

[74] Pernin, *Lessons from the Army's Future Combat Systems,* 52.

[75] Ibid., 112.

[76] Greg Grant, "FCS Not Killed: Casey," DOD Buzz, May 19, 2009, accessed October 14, 2014, http://www.dodbuzz.com/2009/05/19/fcs-not-terminated-casey.

limits for C-130 transportability. The added weight associated with a V-shaped hull, created yet another third point of contention in the FCS program requirements as add on requirements put the vehicle at odds with the original development dimensions.

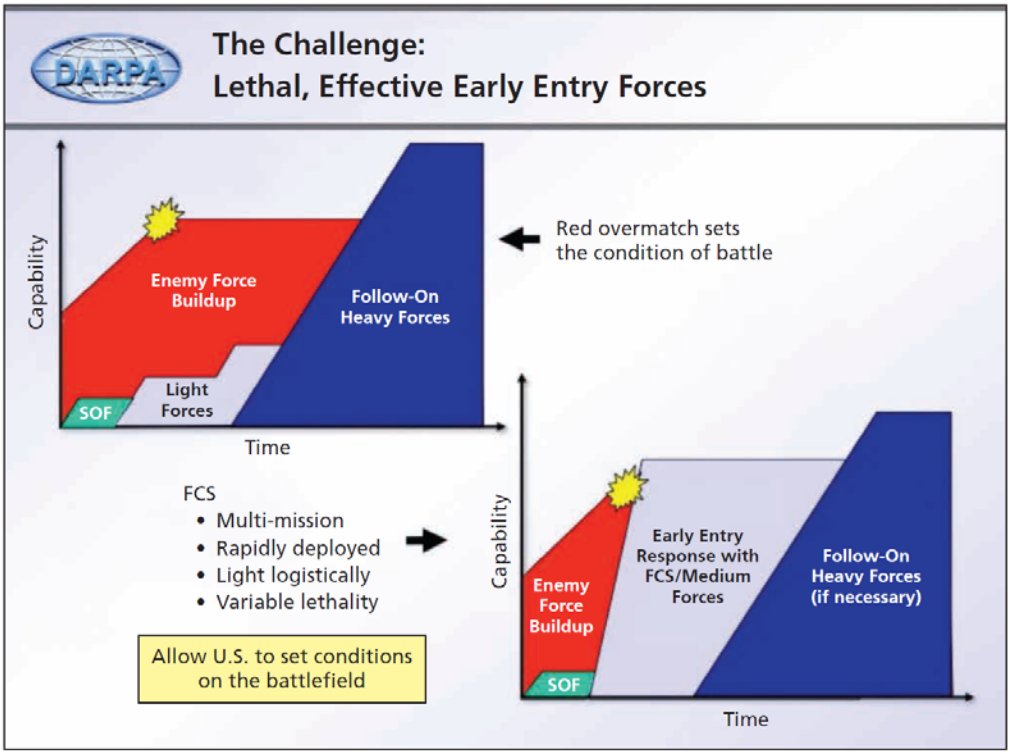

Figure 6. How the FCS Program Improves Strategic Responsiveness

Source: Christopher Pernin, *Lessons from the Army's Future Combat Systems* (Washington, DC: RAND, 2012), 60.

The emerging threats in Afghanistan and Iraq created questions about the design features of the FCS program. However, critics of the FCS claimed the program was never feasible.[77] In similar Army acquisition programs, an operational requirements document (ORD) receives a thorough technical feasibility verification before progressing to Milestone B.[78] The FCS program

[77] Pernin, *Lessons from the Army's Future Combat Systems*, 88.

[78] Milestone B is an acquisition term to explain where a program is in the acquisition process. Once a program has passed milestone B, it can enter the engineering and manufacturing phase.

received only one month to complete the verification.[79] Given the size and nature of the program, one month was a remarkably short amount of time to complete the process properly. As a result, unit design and creation began before operational requirements verification, leading to issues later encountered with meeting transportability and survivability standards. The result for the manned ground element of the FCS program was failure. The requirements were never fully feasible, they never met initial transportability constraints, and they did not adapt to a changing operational environment. The lessons learned from requirements generation during the FCS program should have informed the designers when they again sought to replace the Bradley. However, in the case of the GCV, the problem of matching system requirements to changing operational environments reoccurred.

In less than a year following cancelation of the FCS, the Army issued a RFP that outlined what it sought in the next attempt to replace the BFV. In contrast to both the BFV and the FCS program, the GCV experienced relatively little requirements creep. Although, it could be as simple as that the US Army had a directed threat at the time of development. It remains unclear why the GCV requirements experienced the fewest requirements changes. However, it is clear that initial requirements came into direct competition with the future operating environment as the strategic context shifted to an Asia-Pacific focus.[80]

The new GCV was the first combat system designed to address the IED threat that had become the hallmark of unconventional threats.[81] The GCV had a large list of initial requirements that fell into four categories: protecting the crew against an IED threat, carrying a full squad of

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[79] Ibid, 89.

[80] US Congress, *The Army's Ground Combat Vehicle Program and Alternatives* (Washington, DC: Congressional Budget Office, 2013), 14.

[81] Feickert, *The Army's Ground Combat Vehicle Program: Background and Issues for Congress*, 2.

nine soldiers, maintaining a scalable armor package, and being ready to enter production in seven years.[82] In addition, the new GCV was to be C-17 transportable like the BFV.

The Army's requirement for a nine-man IFV that carried enough armor to protect that crew from an IED explosion was the design specification that ultimately pushed initial GCV designs into the 60 to 80 ton weight class. The nine-man squad requirement is an old requirement that dates back before the initial design of the Bradley. Figure 7 shows a graphical representation of the personnel carrying capacity of various Army combat vehicles. When the Army was developing its first IFV, Army tactical doctrine called for a nine-man infantry squad.[83] The Bradley's original design provided space for nine infantrymen, but as requirements changed to address anti-armor capabilities, the Army reduced the nine-man requirement to six. Since that time, the Army has continued to seek an IFV capable of moving and dismounting soldiers.[84] Today, the unconventional use of the BFV in counter-insurgencies and humanitarian missions puts a premium on the ability to carry more soldiers safely to their destinations.[85] However, with more Soldiers comes a larger chassis that creates more surface area armor. It was also necessary to address the IED threat. Here is where old design necessities, mixed with new requirements, create costly design features.

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[82] US Congress, *Technical Challenges of the U.S. Army's Ground Combat Vehicle Program,* 12.

[83] Bruce Held, *Understanding Why a Ground Combat Vehicle That Carries Nine Dismounted is Important to the Army* (Washington, DC: RAND, 2013), 27.

[84] Ibid.

[85] US Congress, *Technical Challenges of the U.S. Army's Ground Combat Vehicle Program,* 17.

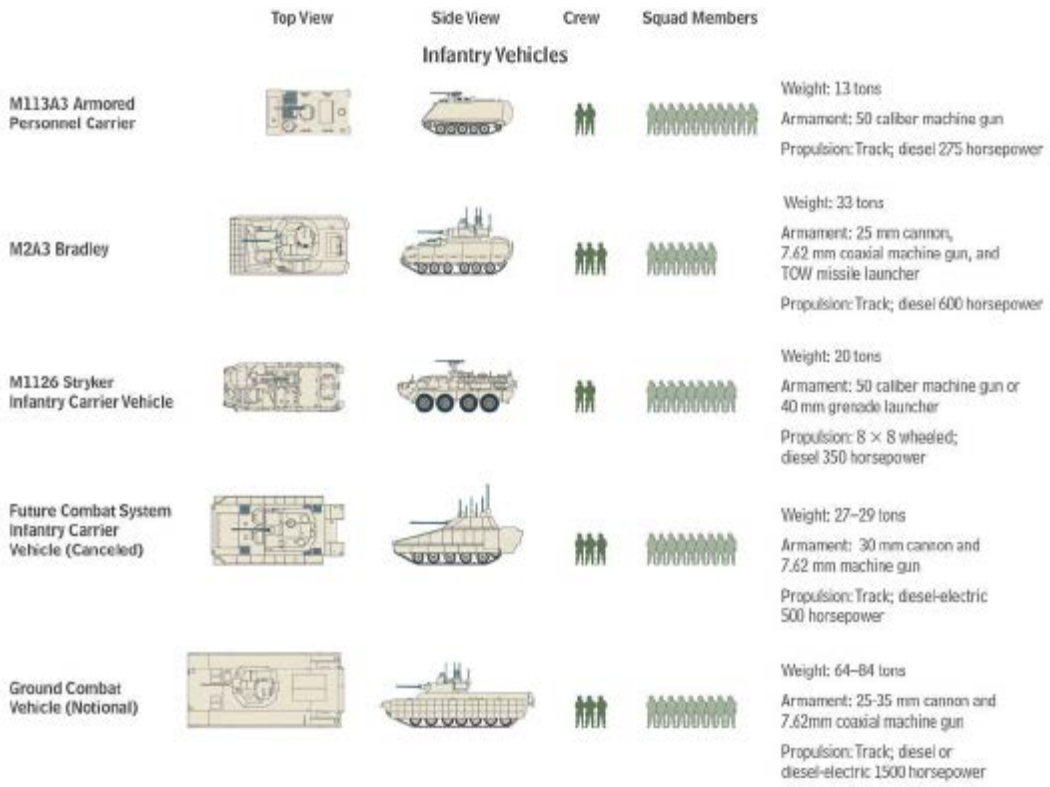

Figure 7. Recent and Planned Armored Vehicles

Source: US Congress, *Technical Challenges of the U.S. Army's Ground Combat Vehicle Program* (Washington, DC: Congressional Budget Office, 2012), 2.

To meet the original design specifications, the GCV grew in weight. If created, it would have replaced the M1A2 Abrams as the heaviest armored combat vehicle in the US Army's inventory.[86] As seen in Figure 8, the GCV's weight might have grown to weigh between 64 and 84 tons. The sheer weight of the GCV was a clear departure from the original FCS concept of a highly transportable system. However, the need to remain mobile on and off rugged terrain was still a design parameter that designers had to consider. Designers of the GCV addressed that need

[86] US Congress, *Technical Challenges of the U.S. Army's Ground Combat Vehicle Program*, 29.

with modular armor. The GCV original design included three armor packages that met the needs of the operating environment.[87] Each armor package would add protection to the GCV at the cost of slower movement and maneuver. The highest level of protection, suited for an IED threat environment, made the GCV the heaviest vehicle on the battlefield.[88] Yet, in contrast to the BFV and MGV of the FCS program, the GCV presented modular options to suit future needs. While not explicitly stated, program design of the GCV shows signs of lessons learned from shortcomings in the FCS program. That is, vehicles designed as part of the FCS program could not adapt to changing tactical environments by using tack on armor or additional weaponry.

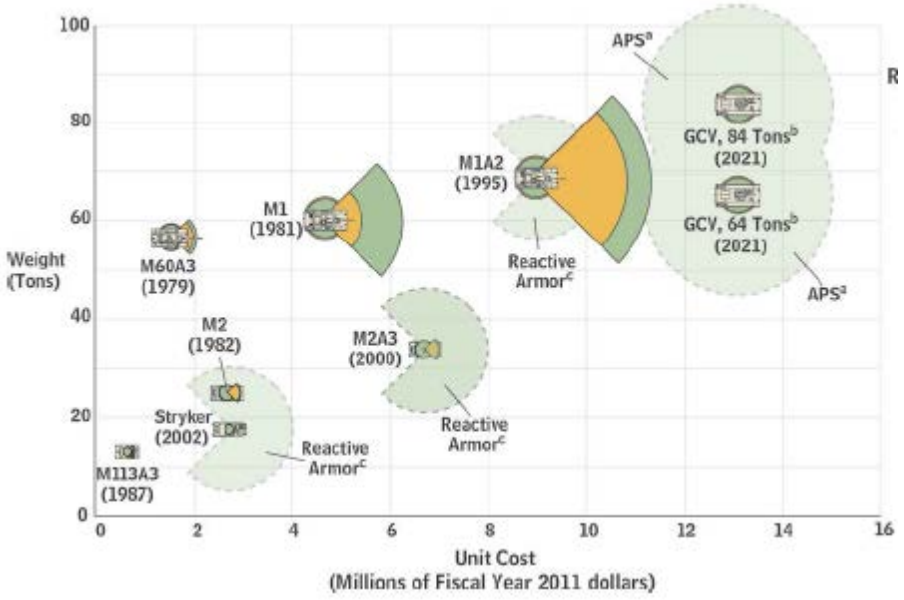

Figure 8. Evolution of Ground Combat Vehicles

Source: US Congress, *Technical Challenges of the U.S. Army's Ground Combat Vehicle Program* (Washington, DC: Congressional Budget Office, 2012), 29.

The evidence demonstrates the Army's inability to develop modest requirement goals that are obtainable within in an acceptable about of time. Each of the three weapon systems had a

[87] US Congress, *Technical Challenges of the U.S. Army's Ground Combat Vehicle Program*, 31.

[88] Ibid.

turbulent history of requirements creep. The wide lens perspective suggests that each weapon system had a unique history of requirement development and subsequent requirement shifts. The evidence supports that developing a logical list of requirements for a new weapon system is difficult for the US Army. The conflict between what the Army wants in the new infantry-fighting vehicle and what it can realistically produce plagues production throughout the system's development cycle. Requirements for the BFV changed quickly and often without a formal doctrine to guide system requirements for most of the BFVs development history. There was harmony in the design process only when doctrine matched the need for the weapon system. The FCS program designed systems to move the Army into the future off an idea that fed initial requirements. When the future veered from original estimates, the FCS could not change with it. The GCV had the least issues with overall requirements creep or development. Its only critique may be the fact its design supported a combat environment that the United States was abandoning. However, common in each weapon system was the fact that as requirements changed so did program costs.

Comparison of System Cost

Recent history has shown the impact of dwindling defense budgets in an era of persistent conflict. Sequestration has caused Army and civil leaders to question where limited funds are spent and their underlying rationale.[89] However, while sequestration is familiar to today's media circles, it is not a new concept. Each Army modernization period has experienced its own trials related to budgetary concerns of varying degrees of severity. The following section examines the effect that system cost had on the development of each weapon system. In the same manner as requirements creep, all three weapon systems had considerable cost growth. This fact supports the

[89] US Congress, *Final Sequestration Report for Fiscal Year 2015* (Washington, DC: Congressional Budget Office, 2015), 1.

link between requirements and cost. However, the Bradley remains a unique study as congressional actions to monitor acquisitions costs did not exist during its development lifetime.

The total costs for the FCS program followed a similar pattern to the BFV but for very different reasons. In the case of the Bradley, requirements shifted violently resulting in fluctuating price estimates. The FCS program had fewer requirements shifts during its development period. However, the program experienced four major restructuring events and relied on very immature technology.[90] The maturity level of the technology needed to make the FCS program function had a direct relationship to the program designers' ability to create strong program cost estimates over the projected 20-year development life cycle.[91] This relationship allowed the overall cost to grow nearly 300 percent from the original estimate, creating doubt and speculation about the Army's new modernization plan.

The rapid increase in overall program cost estimates drew attention from several congressional watch groups. The FCS program entered the Systems Development and Demonstration (SDD) phase in 2003.[92] At that time, the Army envisioned equipping 15 brigades with only 14 components of FCS equipment at an estimated cost of $77.8 billion (2003 dollars).[93] In 2004, the FCS program encountered its first major restructuring. This restructure was in response to the newly appointed Chief of Staff of the Army, General Peter Schoomaker, who wanted "spin-out" technology from the FCS program developed directly for the current fight in

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[90] Andrew Feickert, *The Army's Future Combat Systems (FCS): Background and Issues for Congress* (Washington, D.C., Congressional Research Service, 2009), 9.

[91] Bill Pettus, Jack Wong, Arbi Lazar, *Improving the Future of the Army's Future Combat Systems Project*, Joint Applied Project (Monterey, CA: Naval Postgraduate School, 2009), 25.

[92] US Congress, *The Army's Future Combat System's Program and Alternatives* (Washington, DC: Congressional Budget Office, 2006), xvi.

[93] Pernin, *Lessons from the Army's Future Combat Systems,* 39.

Iraq and Afghanistan. The restructure also included the four mission components of the FCS program, bringing the program to its full complement of 18 systems.[94] The result of the restructure, shown in Figure 9, was a cost estimate increase of 65 percent to a new total of $120 billion.

With that increase, the FCS program should have triggered a congressional review

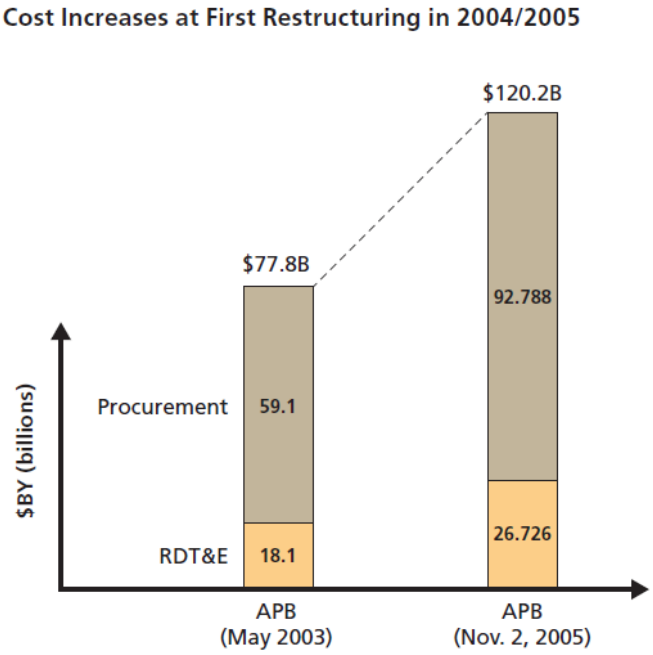

Figure 9. Cost Increases at 2004 Restructuring

Source: Christopher Pernin, *Lessons from the Army's Future Combat Systems* (Washington, DC: RAND, 2012), 39.

according to Nunn-McCurdy Act, but it did not. It is important to understand why it did not. The 65 percent increase in the total system cost far exceeded the 15 percent threshold originally set by the Nunn-McCurdy Act. However, Army designers were able to bypass the congressional review by establishing a new baseline cost of $120 billion for the FCS program in 2004.[95] Since the

[94] Pernin, *Lessons from the Army's Future Combat Systems,* 39.

[95] Moshe Schwartz, "The Nunn-McCurdy Act: Background, Analysis, and Issues," *Congressional Research Service.*

baseline cost is the basis for determining price increases, the new baseline reduced the size of the increase and enabled the FCS program to continue without further review. Amendments to the Nunn-McCurdy Act would later attempt to curb the practice of changing baselines for weapon systems.

After the 2004 restructure, Congress became increasingly skeptical of the FCS program as the GAO and other outside audits began independent study of the associated costs. Led by the House Armed Services and Appropriations Committee, Congress called for an independent cost analysis from the Office of the Secretary of Defense (OSD) Cost Analysis Improvement Group (CAIG).[96] In 2006, one year prior to the second FCS program restructure, CAIG estimated that total cost of the FCS program at $300 billion. This report was twice what the Army was reporting at $160 Billion.[97]

In an attempt to control cost estimates, the FCS program occurred another restructure for a second time in 2007. During this restructuring, the total number of systems decreased from 18 back to the 2003 number of 14. However, the reduction of capability had only a marginal effect on overall system cost.[98] Overall, the FCS program had three very different development profiles, shown in Figure 10. In each profile, the plan rested on immature technologies with variables that

[96] Ibid., 260.

[97] US Congress, *The Army's Future Combat System's Program and Alternatives*, xvi.

[98] Pernin, *Lessons from the Army's Future Combat Systems,* 46.

made cost estimation hard to determine. The inability to estimate future costs became focus of the critics of the FCS program.

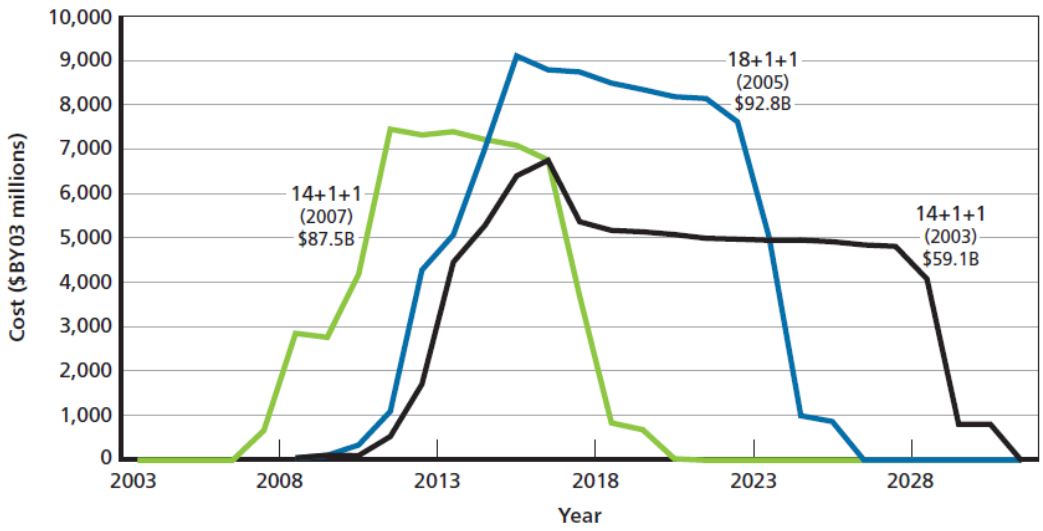

Figure 10. Development profiles of the FCS program

Source: Christopher Pernin, *Lessons from the Army's Future Combat Systems* (Washington, DC: RAND, 2012), 47.

In contrast to both the BFV and the FCS program, relatively little is available regarding cost estimates of the GCV. This is due to the short life span of the GCV program and the fact that cost estimates are not available until a program enters into engineering and manufacturing development.[99] However, it is important to extrapolate the data from sources that do exist since budgetary concerns are one of the main reasons why Army officials recommended cancelation of the program.[100]

[99] US Congress, *The Army's Ground Combat Vehicle Program and Alternatives,*

[100] Feickert, *The Army's Ground Combat Vehicle Program: Background and Issues for Congress*, 9.

In a 2013 CBO report, preliminary data allowed analysts to determine an initial cost estimate for the GCV program. By taking the estimated unit cost of one GCV and the total procurement objective of 1,748 weapon systems, the CBO determined that the total program cost was $28 billion over the course of 16 years.[101] Additionally, the CBO report estimates that at least two billion dollars was required annually between the years 2019 and 2028 once the GCV went into production. Based upon current budget requests, that number could equate to 10 percent of the entire Army's procurement budget in those years.[102] The last Army weapon system to account for 10 percent or more of the Army's procurement budget was the Apache helicopter back in the 1990s.[103] While the numbers associated with the GCV are estimates, they painted a poor financial picture for the GCV and likely affected the program's future. The critical point to this section is that cost estimates for Army ground combat vehicle modernization efforts can affect overall program outcome.

The evidence supports a clear pattern of cost growth in each of the three programs mentioned. This pattern is enough to cause turbulence in weapon systems before they ever get off the design floor, as was true in the case of the GCV. The issue of underestimating original design costs is epidemic and the focus of several studies. In a 2006 RAND report, Mark Arena concluded that historically, actual costs of a weapon system range 50 percent higher than original estimates.[104] These facts represent a long shadow that future weapon programs will have to address if they wish to be successful. However, it is important to note that the RAND study produced that study by analyzing completed programs. Intuitively, this means that, while cost

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[101] US Congress, *The Army's Ground Combat Vehicle Program and Alternative* (Congress of the United States: Congressional Budget Office, 2013), 7

[102] Ibid., 17.

[103] Ibid.

[104] Mark Arena, *Understanding Why a Ground Combat Vehicle That Carries Nine Dismounted is Important to the Army* (Washington, DC: RAND, 2006), xi.

growth is problem, it is not the single source of failure of modernization efforts since programs have been successful despite cost growth.

Conclusion

The Bradley Fighting Vehicle entered the US Army's ground combat vehicle inventory in 1981. Since that time, the Army has invested billions of dollars and years of research to develop a weapon system capable of replacing the functionality of the Bradley. Yet today, the Bradley is in its thirty-fourth year of service and despite a need to replace the aging weapon system, no viable options currently exist. This does not mean that the Army has not fully invested in replacing the BFV. The Army has made two concentrated efforts to replace the BFV in the form of the FCS and GCV. The fact that neither of those two systems ever came to fruition suggests a problem worthy of research.

To uncover the common threads of failure between the FCS and GCV, three development dimensions allowed comparison of the FCS and GCV to the Bradley. Those dimensions were strategic context, requirements, and cost. Analysis of the development dimensions provides an explanation of the FCS and GCV failures. All three dimensions were important to the discussion of each weapon system because the dimensions create a picture of the whole development process. The strategic context defines the threat environment and sets basic initial requirements. Requirements have an associated cost. As context shifts, so do requirements that have a direct impact on overall budgetary considerations. However, in order to appreciate the impact of each development dimension in relation to one another, it was first imperative review the Army's history of ground combat vehicle modernization efforts.

The review of the history of the Army's ground combat vehicle modernization efforts showed how the Army approached each attempt at a new ground combat vehicle in the context of the weapons systems design. The Army spent almost twenty-five years developing the Bradley, which was over twice the amount of time spent on either the FCS or GCV. The FCS was the first

attempt the Army made to replace the Bradley, but FCS was too ambitious in its goals and tied the weapon system success to immature technologies that fell short of programmed expectations. The next attempt at modernization came quickly after the terminated FCS and ultimately tied to the criticism of the FCS program. That criticism would question the utility of replacing the Bradley with something that weighed more than an M1A2 Abrams tank.

Analysis of the Bradley along all three development dimensions highlighted the uniqueness of the BFV and set the base of comparison. The evidence shows that the Bradley benefited from a stable Cold War strategic context that ensured support for a system designed to address a Soviet threat. The stability of the Cold War allowed developers to create system requirements that remained relevant to the strategic context. Even as requirements changed and cost estimates grew, the context and need to build an actual infantry-fighting vehicle kept those dimensions from drawing negative congressional attention to the program. Additionally, today's strict congressional budgetary oversight was not present during the Bradley's development. If the Nunn-McCurdy Act had been in place, the Bradley would have received additional congressional scrutiny. However, the BFV was not replacing an existing Army vehicle. It was a novel vehicle and that allowed for greater leniency over timelines and cost.

By comparing the development dimensions of the FCS and GCV to the standard created by the Bradley, clear differences emerged. First, the strategic context of the FCS and GCV never reached a level of stability that supported the BFV. Second, the manner in which specifications changed for each weapon system leads to the conclusion that the BFV, FCS, and GCV experienced requirement creep. Deeper analysis proved this notion wrong. The Bradley was unique since it based its requirements on lofty, yet tangible goals. In contrast, the FCS and GCV created specification on immature and future technology that did not exist at the time of conception. As future technologies failed to materialize, questions emerged regarding the weapon systems future. Finally, all weapon systems faced cost growth that stressed set budgets. Again,

the Bradley was unique in the sense that congressional budgetary oversight acts were not in place. Had they been the BFV would have received greater scrutiny. The Nunn-McCurdy act was in place for the development of the FCS and GCV, requiring reviews and suspensions for excessive cost growth.

In the end, absent a clear consensus on the operating environment, no set of design parameters for the Bradley's replacement can gain strong support. A lack of strong support from members of the DOD and congressional policy makers contributes to revisions, increased costs, and formal reviews that question the necessity to replace the BFV. However, in the case of the Bradley, the design parameters loosened and specific capabilities received priority, in order to build a vehicle with available technology. The FCS and GCV failed to receive the same level of support. Ultimately, the evidence suggests that if the Army intends to replace the Bradley with a new infantry-fighting vehicle, then it must develop more modest program goals at the start of system design and limit the list of new technologies to avoid criticisms of either design or cost.

Bibliography

Arena, Mark. *Understanding Why a Ground Combat Vehicle That Carries Nine Dismounted is Important to the Army*. Washington, DC: RAND, 2006.

Bradford, Robert. *What Happened to the FCS? An Organizational Change Case Study.* Carlisle Barracks, PA: United States Army War College, 2011.

Burton, James G. *The Pentagon Wars: Reformers Challenge the Old Guard*. Annapolis, MD: Naval Institute Press, 1993,

Creveld, Martin van. *The Transformation of War*. New York: Free Press, 1991.

Demchak, Chris C. *Military Organizations, Complex Machines.* New York: Cornell University Press, 1991.

Feickert, Andrew. *The Army's Future Combat System (FCS): Background and Issues for Congress.* Washington, DC: Congressional Research Service, RL32888, April 28, 2005.

_____*The Army's Future Combat System (FCS): Background and Issues for Congress.* Washington, DC: Congressional Research Service, RL32888, May 12, 2008.

_____*The Army's Future Combat System (FCS): Background and Issues for Congress.* Washington, DC: Congressional Research Service, RL32888, May 29, 2009.

_____*The Army's Ground Combat System (GCV) Program: Background and Issues for Congress.* Washington, DC: Congressional Research Service, RL41597, January 18, 2011.

_____*The Army's Ground Combat System (GCV) Program: Background and Issues for Congress.* Washington, DC: Congressional Research Service, RL41597, February 28, 2014.

Foss, Christopher. *Jane's Armour and Artillery 2011-2012.* Rev ed. New York: James Information Group, 2011.

Gates, Robert. "The National Defense Strategy, Striking the Right Balance." *Joint Force Quarterly,* no. 52 (1st quarter 2009).

Grant, Greg. "FCS Not Killed: Casey." DOD Buzz. Accessed October 14, 2014. http://www.dodbuzz.com/2009/05/19/fcs-not-terminated-casey.

Haworth, W. Blair. *The Bradley and How It Got That Way: Technology, Institutions, and the Problem of Mechanized Infantry in the United States Army (Contributions in Military Studies)*. Connecticut: Greenwood Press, 1999.

Held, Bruce. *Understanding Why a Ground Combat Vehicle that Carries Nine Dismounted is Important to the Army*. Washington, DC: Congressional Budget Office, 2013.

Herbert, Paul H. *Deciding What Has to Be Done: General William E. DePuy and the 1976 Edition of FM 100-5*. Kansas: Combat Studies Institute, 1988.

Hoffman, George F., and Donn A. Starry. *From Camp Colt to Desert Storm: The History of US Armored Forces.* Kentucky: The University Press of Kentucky, 1999.

Lardner, Helen. *The Army's Quest for a New Ground Combat Vehicle*. Carlisle Barracks, PA: United States Army War College, 2010.

Lazar, Arbi., and Bill Pettus. *Improving the Future of the Army's Future Combat Systems Project.* Joint Applied Project. California: Naval Post Graduate School, 2009.

Linn, Brian. *The Echo of Battle: The Army's Way of War*. Boston: Harvard University Press, 2007.

Lynn, Larry. "Some Suggestions for the Army After Next." Combat Studies Institute. Accessed October 20, 2014. http://usacac.army.mil/cac2/CSI/docs/Gorman/06_Retired/02_Retired/02_Retired_1991_99/17/97_DARPA_ForAAN_1May.pdf.

Murray, Williamson. *Army Transformation: A View from the US Army War College*. Seattle: CreateSpace, 2001.

Murray, Williamson. *Military Adaptation in War: With Fear of Change*. New York: Cambridge University Press, 2011.

RAND Arroyo Center, *Lessons from the Army's Future Combat Systems Program.* Santa Monica, CA: RAND Corporation, HQD105725, 2012.

Schwartz, Moshe. *Defense Acquisitions: How DOD Acquires Weapon Systems and Recent Efforts to Reform the Process*. Washington, DC: Congressional Research Service, 2010.

_____"The Nunn-McCurdy Act: Background, Analysis, and Issues." Congressional Research Service. Accessed October 27, 2014. http://fpc.state.gov/documents/organization/145135.pdf.

Trybula, David C. *Big Five Lessons for Today and Tomorrow*. Pennsylvania: United States War College, 2012. Accessed October 21, 2014. http://www.benning.army.mil/library/content/NS%20P-4889.pdf.

US Congress. *A CBO Study: The Army's Future Combat Systems Program and Alternatives.* Washington, DC: Congressional Budget Office, 2006.

_____*Final Sequestration Report for Fiscal Year 2015.* Washington, DC: Congressional Budget Office, 2015.

_____*Technical Challenges to the U.S. Army's Ground Combat Vehicle Program.* Washington, DC: Congressional Budget Office, 2012.

_____*The Army's Future Combat Systems Programs and Alternatives.* Washington, DC: Congressional Budget Office, 2006.

_____*The Army's Ground Combat Vehicle Program and Alternatives.* Washington, DC: Congressional Budget Office, 2013.

United States, Department of Defense. *Defense Budget Priorities and Choices*. Washington, DC: Office of the Secretary of Defense, 2012.

_____Sustaining US Global Leadership: Priorities for 21st Century Defense. Washington, DC: Office of the Secretary of Defense, 2012.

United States, Department of the Army. *Army After Next: A Vision for the Future*. Fort Belvoir, VA: Department of the Army, Research, Development & Acquisition, 1998.

_____*Army Capstone Concept*. Fort Eustis, VA: Training and Doctrine Command, December, 2012.

_____*ADP 3-0, Unified Land Operations*. Washington, DC: HQDA, 2011.

_____*ADP 6-0, Mission Command.* Washington, DC: HQDA, 2012.

_____*Army Mission Command Strategy, FY 13-19, Three–Star Staffing Version.* Fort Leavenworth, KS: Director, Mission Command Center of Excellence, 2013.

_____*Army Modernization Plan, 2012*. Washington DC: Office of the Deputy Chief of Staff, Army, G8, 2011.

_____*Army Strategic Planning Guidance, 2005*. Washington, DC: Office of the Deputy Chief of Staff, Army, G3, 2005.

_____*Field Manual 6–22, Army Leadership*. Washington, DC: HQDA, 2006.

_____*The Army Campaign Plan, 2005*. Washington, DC: Office of the Deputy Chief of Staff, Army, G3, 2005.

_____*The Army Strategy, 2008*. Washington, DC: Office of the Chief of Staff, Army, 2008.

US General Accounting Office, Defense Acquisition: Improved Program Outcomes Are Possible (GAO/T-NSIAD-98-123), Washington, DC, 1998. Accessed August 5, 2014. http://www.gao.gov/archive/1998/ns98123t.pdf.

_____Acquisition Reform: Implementation of Key Aspects of the Federal Acquisition Streamlining Act of 1994 (GAO/NSIAD 98-81), Washington, DC, 1998. Accessed August 5, 2014. http://www.gao.gov/archive/1998/ns98081.pdf.

_____Acquisition Reform: Defense Management Report Savings Initiatives (GAO/NSIAD-91-11), Washington, DC, 1990. Accessed August 5, 2014. http://archive.gao.gov/d21t9/142879.pdf.

_____Best Practices: DOD Training Can Do More to Help Weapon System Programs Implement Best Practices (GAO/NSIAD 99-206), Washington, DC, 1999. Accessed August 5, 2014. http://www.gao.gov/archive/1999/ns99206.pdf.

_____Best Practices: Successful Applications to Weapons Programs Requires Changes in DOD‘s Environment (GAO/NSIAD-98-56), Washington, DC, 1998. Accessed August 5, 2014. http://www.gao.gov/archive/1998/ns98056.pdf.

_____Contract Management: Taking a Strategic Approach to Improving Service Acquisitions (GAO-02-499T), Washington, DC, 2002. Accessed August 5, 2014. http://www.gao.gov/new.items/d02499t.pdf.

_____Defense Acquisitions: Assessments of Major Weapon Programs (GAO-03-476), Washington, DC, 2003. Accessed August 5, 2014. http://www.gao.gov/new.items/d03476.pdf.

_____Defense Acquisition: DOD Faces Challenges in Implementing Best Practices (GAO-02-469-T), Washington, DC, 2002. Accessed August 5, 2014. http://www.gao.gov/new.items/d02469t.pdf.

_____Defense Acquisitions: Factors Affecting Outcomes of Advanced Concept Technology Demonstrations (GAO-03-52), Washington, DC, 2002. Accessed August 5, 2014. http://www.gao.gov/new.items/d0352.pdf.

_____Defense Programs: Opportunities to Reform Key Business Practices, Washington, DC, 1997. Accessed August 5, 2014. http://archive.gao.gov/paprpdf1/158389.pdf.

_____Defense Reform Initiative: Progress, Opportunities, and Challenges (GAO/NSIAD-99-95), Washington, DC, 1999. Accessed August 5, 2014. http://archive.gao.gov/f0902b/161766.pdf.

_____High Risk Series: Defense Weapons Systems Acquisition (GAO-HR 93-07), Washington, DC, 1993. Accessed August 5, 2014. http://archive.gao.gov/d36t11/148225.pdf.

_____*The Army's Proposed Close Combat Vehicle Team.* Washington, DC: GAO, 1997.

Wasserbly, Daniel. "Pentagon Budget 2015: Dooms GCV." HIS Jane's 360, March 4, 2014. Accessed October 14, 2014. http://www.janes.com/article/34841/pentagon-budget-2015-army-2-usd120-5-billion-proposal-drops-end-strength-dooms-gcv.